American Journal of Experimental Agriculture
3(3): 606-630, 2013

SCIENCEDOMAIN *international*
www.sciencedomain.org

Determinants of Commercialization of Smallholder Tomato and Pineapple Farms in Ghana

Samuel Asuming-Brempong[1*], John K. Anarfi[2], Samuel Arthur[3] and Seth Asante[4]

[1]Department of Agricultural Economics and Agribusiness, University of Ghana, Legon, Accra.
[2]Regional Institute of Population Studies, University of Ghana.
[3]Institute of Professional Studies (IPS), Legon, Accra.
[4]Department of Agricultural Economics and Agribusiness, University of Ghana. Accra.

Authors' contributions

This work was carried out through collaboration among all authors. Each author made a significant contribution to the final document. All authors read and approved the final manuscript.

Research Article

Received 22nd December 2012
Accepted 5th April 2013
Published 15th May 2013

ABSTRACT

Smallholder commercialisation may be broadly defined as the situation where farmers of small individual and family farms have greater engagement with markets, either for inputs, outputs, or both. A key premise of commercialization as a development strategy is that markets provide increased incomes to households who are able to maximize the returns to land and labor through market opportunities, using earned income for household consumption in ways that are more efficient than subsistence production. This study assesses the characteristics of smallholder farmers in Ghana using tomato and pineapple production as a case study; analyses the relationship between commercialization and smallholder land holdings; assesses the determinants of commercialization of smallholder agriculture, as well as the benefits or otherwise of smallholder farmers from commercialization; and discusses how commercialization affects household food security among smallholder farmers. Descriptive statistics, correlations and regression analysis are used to describe the characteristics of smallholder farmers and determine the key factors

**Corresponding author: Email: asumbre20@hotmail.com;*

that influence household decision to undertake commercialization among both tomato and pineapple farmers. Based on the study, it was found that 96.3 percent of the respondents in the study communities are farmers; and they fall between the ages of 15 and 59 years (91%), which indicates that they are relatively young. The key determinants of commercialization among tomato farmers are land productivity and labour productivity. Similarly, the main determinants of commercialization among pineapple smallholder farmers are land productivity and savings. The study recommends that both public and private agencies work should together to facilitate the move of smallholder farmers from mainly subsistence to commercialization because it comes with several benefits, including higher household incomes, and improvements in household food security.

Keywords: Smallholder farmer; commercialization; determinants; productivity; income.

1. INTRODUCTION

A large literature exists on commercialisation — broadly defined as having greater engagement with markets, either for inputs, outputs, or both — of small, family farms. A key premise of commercialization as a development strategy is that markets provide increased incomes to households who are able to maximize the returns to land and labor through market opportunities, using earned income for household consumption in ways that are more efficient than subsistence production [1,2]. Research has shown that smallholder farmers comprise 85% of the farming population worldwide. The Ministry of Food and Agriculture (MoFA) in Ghana estimates that about 80 percent of the country's agricultural output comes from smallholder farmers. In Kenya for instance, 75 percent of national food needs and raw materials are provided by smallholder farmers, yet only 30 percent of them have access to credit facilities and other services to help them increase productivity. Evidence from elsewhere in sub-Saharan Africa indicates the key role of cash crops in driving processes of agricultural intensification and productivity growth through the development of credit facilities and input/output markets [3,4,5]. [6] show the importance of institutional arrangements in such market development and the consequences of cash crop development for non-cash crop productivity gains.

The term 'smallholder' usually has embedded in it the connotation of limited land availability. Others sketch a broader view of 'resource-poor' farmers, such as those with limited capital (including animals), fragmented holdings, and limited access to inputs. [7] note that the number of animals per farmer or household may be a misleading definition, indicating that resource-poor livestock keepers are a very diverse group. Ghana's Poverty and Social Impact Analysis (PSIA) done in 2004 implicitly makes a similar argument for Ghanaian farmers, stressing that different resource and risk conditions better define smallholders than a simple measure of landholdings. The PSIA identifies eight major types of risks faced by smallholders in Ghana, including production risks, credit risks, income risks, labour and health risks, nutritional risks, price risks, vulnerability to unethical trading practices, and employment risks [8]. Others have similarly noted that two farmers with the same farm size, but one producing a high-value crop for the market while the other produces a staple for home consumption, cannot be meaningfully compared [6].

In more conceptualized terms, however, defining smallholders tend not to be a simple exercise. While quantitatively precise definitions are elusive, in looking across a variety of working definitions for Ghana and elsewhere several key themes may be noted, among them are size holding, wealth, market orientation and levels of vulnerability to risk. In

general, land holding is perhaps the most direct and easily introduced indicator of who smallholders are. The Ministry of Food and Agriculture [9] maintains that agriculture is predominantly on a smallholder basis in Ghana, and about 90% of farm holdings are less than 2 hectares in size.

2. PROBLEM STATEMENT AND OBJECTIVES

Ghana has an agrarian economy, and the agricultural sector is predominantly rain-fed. As a result, agricultural production activities have generally been tied to the rainfall patterns from year to year. Irrigated agriculture continues to be used in a rather limited way in Ghana. In 2009 for example, it was estimated that the total area under irrigation was about 29,804 hectares, representing about 0.2% of the total land area; while the area under inland waters was approximately 1.1 million hectares representing 8% of the land area. Furthermore, fertilizer usage in Ghana averaged about 34,000 mt per annum for the decade, and this was one of the lowest in Africa. It was also estimated in the 2000/2001 crop year that fertilizer use was only about 8 kg/ha in Ghana (which has since not changed much), compared to 99 kg/ha in Latin American countries, 109 kg/ha in South Asian countries, and 149 kg/ha in East and South East Asian countries. Because fertilizer use among farmers in Ghana is rather minimal, coupled with the low fertility nature of most soils in the country, agricultural productivity is generally low. Estimates indicate that among the major crops including cocoa, maize and cassava, average yields are about 30 to 50 percent of achievable yields [9,10].

The agricultural sector in Ghana is made up of five sub-sectors, namely: (1) cocoa (13%), (2) all other crops beside cocoa (64%), (3) livestock (including poultry) (7%), (4) fisheries (5%), and (5) forestry and logging (11%). Most food crop farms are intercropped, and mixed farming is commonly practiced by smallholders. Mono cropping is mostly associated with commercial farms. There are some large-scale farms and plantations especially for oil palm, rubber and coconut; and to a lesser extent, maize, rice and pineapples. The traditional slash and burn continue to be predominant, particularly across the southern forest belt where trees and stumps hinder mechanization. The low yields for most crops make it such that food crop farmers remain among the poorest groups in Ghana. The adoption of improved technologies among farmers is still low in Ghana and at different levels across the different sub-sectors, except in the case of commercial farms (including non-traditional export crops).

During the last decade in particular, government efforts to improve the agricultural sector has focused primarily on agricultural modernization, which is perceived as a “process of transforming traditional agriculture into a commercially oriented one” Such a transformation involves the use of new technologies and practices that maximise the productivity of both land and labour, and is environmentally friendly. The agricultural modernization process also has implications for the knowledge base of the agents involved, the level of available technology, and the level of infrastructure development as well as the state of service institutions [8]. Thus, modernizing agriculture in Ghana seems to also suggest the promotion of commercial agriculture particularly among smallholder farmers who tend to be more subsistence oriented.

In considering the commercialization of smallholder agriculture in Ghana, certain key questions become relevant. For example, (a) Under what conditions may small farms be commercialised? (b) To what extent does commercialisation benefit smallholding households, and does it improve or worsen food security for the household? (c) What is the relationship between commercialisation and the size of land holdings of smallholder farmers, and does commercialization raise risks in the markets for these farmers? The objective of

this paper is to address the foregoing questions, among others. In particular, the paper describes the characteristics of smallholder farmers using tomato and pineapple production as a case study; analyses the relationship between commercialization and smallholder land holdings; assesses the determinants of commercialization of smallholder agriculture, as well as the benefits or otherwise of smallholder farmers from commercialization; and discusses how commercialization affects household food security among smallholder farmers.

3. STUDY AREAS AND DATA SOURCES

Ghana is located in the middle of the West African sub-region and covers an area of 238,540 km^2 with a tropical humid climate. The south has a double maxima rainfall (May-June and September-October) whereas the north has a single long rainy season (June-August). The dry, dusty, Harmattan winds occur from January to March. Agriculture in Ghana largely follows the country's ecological and climatic patterns. The country has three broad ecological zones, which are the forest, forest-savannah transition, and the savannah zones [9,10]. These broad categories are further sub-divided into the coastal savannah, rainforest, semi-deciduous forest, forest-savannah transition, Guinea savannah and Sudan savannah (Fig. 1). The forest zone, comprising the tropical high rain forest and semi-deciduous forest, covers about one-third of the country (8.2 million hectares), and supports about two-thirds of the country's population [11]. Most of the economic activities of the country are also located here, including activities associated with cocoa, minerals, oil palm, rubber, and timber. The northern savannah zone covers about 66% (15.7 million hectares) of the country's total area. Industrial crops such as cotton and sheanuts, along with food crops such as rice, maize, sorghum, millet and yam are important in the zone. The forest-savannah transition (a blend of the forest and savannah) lies in-between the two zones, and noted for cereals, particularly maize, as well as root and tuber crop production [10].

The study sample consisted of 300 farmers randomly selected from the study areas. In all, three districts were involved in the study, namely: Techiman Municipality and Kintampo South District in the Brong Ahafo Region (160 respondents), which fall within the transitional zone; and Akuapem South District in the Eastern Region (140 respondents), which also fall within the coastal savannah-forest fringes (Fig. 2 and Table 1). Among the 160 respondents, 116 grew tomatoes in addition to other crops, and 44 do not; while among the 140 respondents, 52 cultivated pineapple and 88 do not. These districts fall under three traditional authorities as well, namely Akwapm South, Nkoranza and Techiman Traditional areas, respectively; and the enumeration areas were Fotobi, Pokrom, Pamdu and Tuobodom, which are major producing centers for tomato (Pamdu and Tuobodom) and pineapple (Fotobi and Pokrom).

Table 1. Study districts and enumeration areas

Districts	Enumeration area	Number of respondents	Percent of sample
Akuapem south	Fotobi/Pokrom	140	46.7
Kintampo south	Pamdu	67	22.3
Techiman municipality	Tuobodom	93	31.0
Total		300	100.0

Source: Household Survey, Nov/Dec 2010

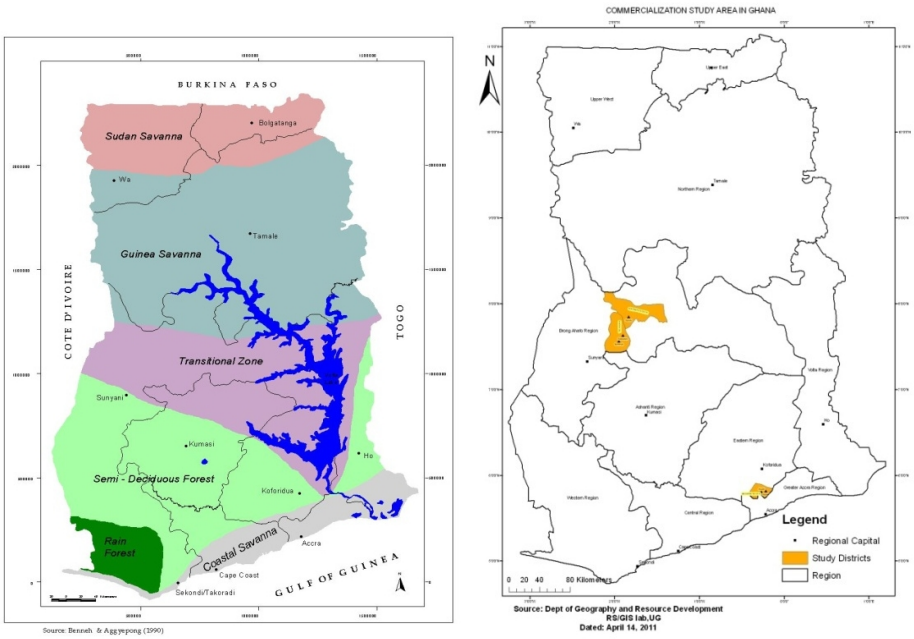

Fig. 1. Ghana's agro-ecological zones showing the study districts

Majority of the households (i.e. 256 farmers or 87.4%) did not have project farmers or farmers that belonged to any on-going projects (Table 2). That is, these were individual private farmers who did not enjoy any support from government programmes or even local farmer associations. Most of the farmer based groups were found in the Akwapem South District, and the most important project they belonged to was the Millennium Development Account (MIDA) project that provides support for smallholder commercial farmers.

Table 2. Response on whether or not the household has project farmers

District	Does the household have project farmers	
	Yes	No
Techiman Municipality	2 (0.7%)	85 (29.0%)
Kintampo South	2 (0.7%)	65 (22.2%)
Akuapem South	33 (11.3%	106 (36.2%)
Total	37 (12.6%)	256 (87.4%)

Source: Household Survey, Nov/Dec 2010

In Tuobodom, some of the farmers indicated that they belong to just one farmer based cooperative which is Tuobodom Tomato Growers Association. In Pamdu two farmer based groups were found – Pamdu Tomato Growers Association and Cashew Growers Association. Farmers in Fotobi and Pokrom however had more farmer based groups. In Fotobi there were Fotobi Cooperative, Apesika Cooperative, Ghana Agricultural Workers Union (GAWU) and Pineapple Growers Association. In Pokrom, eight farmer based groups were identified. These were Unity Animal Farm, Pokrom Youth in Agriculture, Nsaba Cooperative, Adonten Cooperative, Adonten Pineapple Growers Association, New Patriotic Pineapple Farmers Association, Kwasikrom Apramso Cooperative, DVG Cooperative and Patriotic Cooperative.

The importance of probing into the existence of agricultural projects (either government or non-government) in the study areas was to establish whether commercialization of smallholder farms had been driven largely by such projects and the support they provide. Based on the Focus Group Discussions (FGDs) and Key Informant (KI) interviews, which were conducted in all study communities in the three districts, it was realized that the move towards commercialization had been driven by different facilitating factors for tomato and pineapple production. Whereas commercialization of tomato production has been driven more by tradition (i.e. the crop has traditionally been produced there) and the relative profitability of the crop in the study districts, the commercialization of pineapple production has been greatly influenced by projects, especially when MoFA declared the Akwapim South District a pineapple zone several years earlier. This partially explains why there were only a few farmer associations in Pamdu and Tuobodom but several in Fotobi and Pokrom.

The study used both qualitative and quantitative primary data, which were augmented with relevant secondary data. In all the districts covered by this study, primary data collection followed a multi-stage sampling design. The first stage consisted of a purposive selection of districts noted for tomato and pineapple production respectively, and also reasonably accessible. The second and third stages consisted of a random selection in each case of the communities and households within each community to ensure that each household in the communities had an equal chance of being selected. Household interviews using structured questionnaires were then conducted. In addition, focus group discussions (FGDs) were conducted in each community with about 8 to 10 people in each group, and both males and females well represented. Also, Key Informant (KI) interviews were done with opinion leaders in each community. Relevant secondary data were obtained from the Ghana Statistical Service (GSS) and MoFA at the national/regional and district offices.

4. METHOD OF ANALYSIS

Data analysis used statistical and econometric approaches. Descriptive statistics including means, standard deviation, correlations and scatter plots, among others, were employed to show the demographic characteristics of the study communities, both in terms of the total sample as well as for tomato and pineapple sub-samples. Regression analysis was used to determine the key factors that influence household decision to undertake commercialization among both tomato and pineapple farmers. Furthermore, correlation analyses were done to show the relationship between commercialization index (computed as the ratio of the value of output sold to total estimated value of farm production) and the value of farm sales as well as land size, and food security and key related variables such as age and education, among others.

5. RESULTS AND DISCUSSION

5.1 Demographic Characteristics

The data is presented first as a total sample of 300 respondents (Table 3) to show their demographic characteristics. The respondents were mostly males forming 91.7%, mostly within the age of 15 to 59 years (91%). An overwhelming number of the Household heads who were married fell into the category of monogamy (74%). The singles among the respondents were just 10%. One significant finding from the data is the large number of respondents that can both read and write. They formed 71% of the total sample. However, the levels of education were mostly around first cycle with JCE/BECE qualification. As expected, 96.3% of the respondents were farmers. It should be noted that farmers in the study districts grow tomato and pineapple which are mainly grown for cash, and in addition several food crops both for cash and subsistence. Besides livestock which farmers in the study districts keep, the major other crops grown by tomato farmers in the two districts include maize, cassava, yam, cocoyam, groundnuts and vegetables. In the Akwapim South district, pineapple farmers also grow mainly maize, cassava, plantain and vegetables, and some tree crops such as citrus and oil palm.

A closer look at the data revealed that the farm incomes reported by some respondents were either too low or too high (annual farm incomes ranged between a low GH₵12 to a high GH₵100,000). These outliers were therefore identified and removed from the data before further analysis were done to avoid the bias that such outliers could introduce into the analysis.

5.2 Descriptive Statistics of the Total Sample

5.2.1 Commercialization index

Table 4 shows the descriptive statistics for the whole sample. An index of commercialization was computed for the entire sample. This measures the ratio of output sold in the 2010 growing seasons evaluated at their market prices to the value of the output harvested whether sold or not sold. The average commercialization index was 0.64 with standard deviation of 0.17, implying that in general farm households sold more than 50 percent of their output.

5.2.2 Farm income

Overall, the estimated average income of the respondents from all economic activities was about 636 dollars with standard deviation of 679 dollars. The income was estimated using the farm and non-farm incomes in the 2010 farming season, and were estimated for all the farmers involved in the study.

Table 3. Demographic characteristics of the household heads

Gender	Techiman Municipality	Kintampo South	Akwapem South	Total
Male	88(29.3)	60(20)	127(42.3)	275(91.7)
Female	5(1.7)	7(2.3)	13(4.3)	25(8.3)
Total	93(31.0)	67(22.3)	140(46.6)	300(100)
Age				
15-59 Years	87(29)	62(20.7)	124(41.3)	273(91.0)
>60 Years	6(2)	5(1.7)	16(5.3)	27(9.0)
Total	93(31)	67(22.4)	140(46.6)	300(100)
Marital Status				
Married – monogamous	69(23.0)	43(14.3)	110(36.7)	222(74.0)
Married polygamous	3(1.0)	1(0.3)	3(1.0)	7(2.3)
Single	8(2.7)	15(5.0)	7(2.3)	30(10.0)
Divorce	8(2.7)	6(2.0)	10(3.3)	24(8.0)
Widow	1(0.3)	0	7(2.4)	8(2.7)
Widower	0	0	1(0.3)	1(0.3)
Separated	4(1.3)	2(0.7)	2(0.7)	8(2.7)
Total	93(31.0)	67(22.3)	140(46.7)	300(100)
Literacy Status				
Can read and write	68(22.6)	47(15.7)	98(32.7)	213(71.0)
Can read only	8(2.7)	4(1.3)	9(3.0)	21(7.0)
Cannot read or write	17(5.7)	16(5.3)	33(11.0)	66(22.0)
Total	93(31.0)	67(22.3)	140(46.7)	300(100)
Educational Status				
Post Grad Diploma	0	1(0.3)	0	1(0.3)
Univ. Diploma/Degree	3(1.0)	3(1.0)	1(0.3)	7(2.3)
Non Univ. Diploma	4(1.3)	2(0.7)	4(1.3)	10(3.3)
MSCE/WASSCE	27(9.0)	15(5.0)	43(14.3)	85(28.3)
JCE/BECE	34(11.3)	31(10.3)	45(15.0)	110(36.7)
PSLC	2(0.7)	0	6(2.0)	8(2.7)
None	23(7.7)	15(5.0)	41(13.7)	79(26.3)
Total	93(31.0)	67(23.3)	140(46.7)	300(100)
Main Occupation in the last 6 months				
Farming	88(29.4)	63(21.0)	138(46.0)	289(96.4)
Salaried Employee	1(0.3)	3(1.0)	0	4(1.3)
Family Business, Self-Employed	3(1.0)	0		4(1.3)
Non-Worker	0	0	1(0.3)	1(0.3)
Other	1(0.3)	0	1(0.3)	2(0.7)
Total	93(31)	66(22)	140(46.7)	300(100)

NB: Percentages in parenthesis
Source: Household Survey, Nov/Dec 2010

5.2.3 Land size (ha)

This was computed using food crop farms in the sample (except outliers) which included tomatoes and pineapple and other crops. It was realized that among the entire population the average land size was 1.41 hectares with standard deviation of 1.51.

5.2.4 Value of crop production (US$)

The entire crop produced for the 2010 season was valued at the average market prices in the local currency (Ghana Cedis), and using the nominal exchange rate of the Cedi to the Dollar (i.e. GHC1.45 to US$1.00 in 2010). The average value of crop production sales was $488 with standard deviation of $579.

5.2.5 Salaried job (e.g. police, school, teacher, etc)

Some of the respondents were both partly farmers and partly working in a salaried job. In the total population, these were only 22 (i.e. 1.6%), and the average income they earned from these salaried jobs was $1,500 with a standard deviation of $1,327.

Table 4. Descriptive statistics of the total sample

	Mean	SD	Median	N
Index: value of output sold/ total est. value of farm production	0.64	0.17	0.67	288
Farm [crop, livestock] income (US$)	575.77	657.61	331.03	288
Non-farm income (US$)	218.58	261.26	137.93	79
Total income (US$)	635.73	679.39	388.11	288
Land size (ha)	1.41	1.51	0.81	288
Value production of crops, US$	487.74	579.41	248.28	288
Gender household head	0.92	0.28	1.00	288
Size of household [no persons in household]	4.16	2.14	4.00	288
Education:				
• years schooling of household head	10.03	4.99	9.00	288
• years of schooling of wife or head if female-headed	11.43	7.99	9.00	21
Salaried Job (e.g. police, school teacher, etc.) [Yes/No]	1499.75	1326.84	1292.76	22
Business [Yes/No]	735.97	899.90	206.55	92
Land productivity, value of crop in US$/ha	533.20	861.19	219.67	288
Labour productivity, value of crop in US$/ labour days	39.75	192.60	5.17	263
Irrigated land accessed (i.e both pump and hand irrigation) ha	1.18	0.74	1.21	29

5.2.6 Business

This is made up of the proportion of respondents who owned their own enterprises or who have operated any non-agricultural income-generating enterprise that produces goods or services (including those who owned a shop or operated a trading business). The value of the average income from these sources was $735.97 with a wide dispersion (i.e.899.90 standard deviation), and there were 92 such respondents in the whole sample (Table 4).

5.2.7 Land productivity (output of crop per ha in value terms, i.e. US$/ha)

This measures the productivity of the land as the ratio of output per hectare, and valued at the average market price of the product. The average land productivity value of crops

($533.20) had a high standard deviation (i.e. $861.19/ha) which showed that the output levels were widely dispersed (Table 4).

5.2.8 Labour productivity (value of crop per labour Day, i.e. US$/man day)

This measures the ratio of value of output in US dollars and total number of days of labour. The results show that the value of the average output was $39.75/ man day with a standard deviation of $192.60/man day (Table 4).

5.2.9 Irrigated land used by farmers (ha)

This refers to the amount of land that was under formal irrigation during the crop season. The study showed that no land in all the study communities was under formal irrigation. However, hand irrigation and pump irrigation are both practiced in both communities by farmers who have their lands near sources of water and are also able to afford the irrigation pump and other equipment. Information from the FGDs and KI interviews revealed that during certain periods of the year, some farmers convey water to their tomato and pineapple farms by head loads and trucks and store in large tanks and other containers for irrigation.

5.3 Descriptive Statistics Based on the Two Study Regions

Tables 5 and 6 show the descriptive statistics for Brong Ahafo Region and Eastern Region respectively. Comparing the values between the two regions, it was observed that the mean values are higher among Brong-Ahafo farmers than Eastern region farmers. However, in terms of education, the average number of years in school by the Eastern region farmers is higher than the years of schooling of farmers in Brong-Ahafo region. The large standard deviation among the pineapple growers shows that the mean values are not evenly or closely dispersed among farmers.

Between the tomato growers and non-tomato growers the mean values were higher in commercialization index, total income, value of sales of crops, salary, business, labour and land productivity among tomato growers. However, the average land size used by non tomato growers was higher (i.e. 1.87 ha) as compared to 1.44 ha of tomato growers (Tables 7 and 8).

Table 5. Descriptive statistics of farmers in the Brong Ahafo region (Techiman Municipality/Kintampo south)

	Mean	SD	Median	N
Comm Index: value of output sold/ total est. value of farm production	0.67	0.16	0.70	152
Farm [crop, livestock] income (US$)	738.01	744.93	441.38	152
Non-farm income (US$)	331.03	302.66	206.90	40
Total income (US$)	825.12	765.22	589.49	152
Land size (ha)	1.54	1.73	1.21	152
Value production of crops, US$	641.96	659.99	408.62	152
Gender household head	0.92	0.27	1.00	152
Size of household [no persons in household]	4.18	2.33	4.00	152
Education:				
• years schooling of household head	9.82	4.61	9.00	152
• years of schooling of wife or head if female-headed	9.60	5.74	9.00	10
Salaried Job (e.g. police, schoolteacher, etc)Yes/No	2060.82	1352.07	2068.62	13
Business [Yes/No]	719.51	792.69	516.90	45
Land productivity, value of crop in US$/ha	697.69	1051.27	295.67	152
Labour productivity, value of crop in US$/days labour	65.95	257.17	129.02	144
Irrigated land accessed, ha	0.99	0.36	0.81	16

Table 6. Descriptive statistics of farmers in the Eastern region (Akuapem South)

	Mean	SD	Median	N
Comm Index: value of output sold/ total est. value of farm production	0.60	0.18	0.63	136
Farm [crop, livestock] income (US$)	394.45	485.70	203.45	136
Non-farm income (US$)	103.24	138.32	41.38	39
Total income (US$)	424.05	490.69	237.76	136
Land size (ha)	1.26	1.22	0.81	136
Value production of crops, US$	315.38	412.05	150.00	136
Gender household head	0.91	0.29	1.00	136
Size of household [no persons in household]	4.15	1.91	4.00	136
Education:				
• years schooling of household head	10.28	5.39	9.00	136
• years of schooling of wife or head if female-headed	13.09	9.57	8.00	11
Salaried Job (e.g. police, schoolteacher, etc.) [Yes/No]	689.31	792.92	206.55	9
Business [Yes/No]	751.73	1000.23	206.55	47
Land productivity, value of crop in US$/ha	349.36	525.36	171.35	136
Labour productivity, value of crop in US$/days labour	8.04	19.01	2.17	119
Irrigated land accessed, ha	1.43	1.00	1.21	13

Table 7. Descriptive statistics of farmers in Brong Ahafo region (Tomato Growers)

	Mean	SD	Median	N
Index: value of output sold/ total est. value of farm production	0.68	0.16	0.71	116
Farm [crop, livestock] income (US$)	829.46	771.65	568.62	116
Non-farm income (US$)	299.67	277.01	186.21	31
Total income (US$)	909.54	795.88	634.49	116
Land size (ha)	1.44	1.61	1.21	116
Value production of crops, US$	732.29	698.74	444.83	116
Gender household head	0.94	0.24	1.00	116
Size of household [no persons in household]	3.96	2.22	4.00	116
Education:				
• years schooling of household head	10.01	4.49	9.00	116
• years of schooling of wife or head if female-headed	11.33	6.74	9.00	6
Salaried Job (e.g. police, schoolteacher, etc.) [Yes/No]	2248.89	1365.94	2068.62	9
Business [Yes/No]	778.75	802.70	516.90	34
Land productivity, value of crop in US$/ha	824.01	1154.82	471.43	116
Labour productivity, value of crop in US$/days labour	78.22	290.03	10.67	111
Irrigated land accessed, ha	1.01	0.38	1.01	14

Table 8. Descriptive statistics of farmers in Brong Ahafo region (non tomato growers)

	Mean	SD	Median	N
Index: value of output sold/ total est. value of farm production	0.64	0.14	0.63	36
Farm [crop, livestock] income (US$)	443.35	566.23	281.55	36
Non-farm income (US$)	439.08	376.62	310.34	9
Total income (US$)	553.12	587.60	362.24	36
Land size (ha)	1.87	2.05	1.21	36
Value production of crops, US$	350.88	401.09	186.56	36
Gender household head	0.86	0.35	1.00	36
Size of household [no persons in household]	4.89	2.55	5.00	36
Education:				
• years schooling of household head	9.22	4.99	9.00	36
• years of schooling of wife or head if female-headed	7.00	2.83	8.00	4
Salaried Job (e.g. police, schoolteacher, etc.) [Yes/No]	1637.68	1411.42	1292.76	4
Business [Yes/No]	536.43	767.92	206.55	11
Land productivity, value of crop in US$/ha	290.65	403.54	137.44	36
Labour productivity, value of crop in US$/days labour	24.67	64.18	4.27	33
Irrigated land accessed, ha	0.81	0.00	0.81	2

In the Eastern region, between the pineapple growers and non pineapple growers the mean values were higher in the commercialization index, total income, land size, value of sales of

crops, salary, business, labour and land productivity among pineapple growers. However, there was no female household head cultivating pineapple but majority of the female household heads are cultivating other crops (Tables 9 and 10).

Table 9. Descriptive statistics of farmers in Eastern region (pineapple growers)

	Mean	SD	Median	N
Index: value of output sold/ total est. value of farm production	0.63	0.18	0.64	52
Farm [crop, livestock] income (US$)	632.53	551.31	486.21	52
Non-farm income (US$)	111.11	171.76	41.38	18
Total income (US$)	670.99	554.65	517.24	52
Land size (ha)	1.45	1.28	1.21	52
Value production of crops, US$	571.55	488.84	434.48	52
Gender household head	0.98	0.14	1.00	52
Size of household [no persons in household]	4.12	1.62	4.00	52
Education:				
• years schooling of household head	10.40	4.58	9.00	52
• years of schooling of wife or head if female-headed	-	-	-	-
Salaried Job (e.g. police, schoolteacher, etc.) Yes/No	749.66	891.40	361.73	4
Business [Yes/No]	874.31	1099.69	206.55	22
Land productivity, value of crop in US$/ha	565.42	546.97	330.63	52
Labour productivity, value of crop in US$/days labour	14.52	28.11	5.00	45
Irrigated land accessed, ha	1.45	1.04	1.21	12

Table 10. Descriptive statistics of farmers in Eastern region (non-pineapple growers)

	Mean	SD	Median	N
Index: value of output sold/ total est. value of farm production	0.59	0.17	0.63	84
Farm [crop, livestock] income (US$)	247.07	373.42	103.45	84
Non-farm income (US$)	96.49	105.69	48.28	21
Total income (US$)	271.19	375.16	115.52	84
Land size (ha)	1.15	0.81	1.18	84
Value production of crops, US$	156.81	250.52	76.55	84
Gender household head	0.87	0.34	1.00	84
Size of household [no persons in household]	4.17	2.08	4.00	84
Education:				
• years schooling of household head	10.20	5.87	9.00	84
• years of schooling of wife or head if female-headed	13.09	9.57	8.00	11
Salaried Job (e.g. police, schoolteacher, etc.) Yes/No	641.03	809.28	206.55	5
Business [Yes/No]	643.86	912.97	643.86	25
Land productivity, value of crop in US$/ha	215.60	466.63	103.44	84
Labour productivity, value of crop in US$/days labour	4.10	8.15	1.33	74
Irrigated land accessed, ha	1.21	-	1.21	1

5.4 Correlation Analysis of Key Variables

In order to demonstrate the relationship between commercialization and the value of farm sales as well as land holdings by farmers, correlation analysis and related scatter plots were done for each region. [The respective scatter diagrams are available upon request].

The correlation between the value of farm sales and land size in the Brong-Ahafo region is significant and positively related (r=0.217). In the Brong-Ahafo region, total labour use is positively related to value of sales which conforms to the sign expected but not significant, whiles fertilizer use is negatively related (did not conform to sign expected) to value of sale and also not significant (Table 11).

The relationship between the value of farm sales in the Eastern region was positive for fertilizer use, land size and total labour use, which was the only significant variable with r = 0.228 (Table 12).

The correlation between commercialization index and land size as well as fertizer use in the Brong-Ahafo region were not significant and negatively related which did not conform to expectation. Also, farm income and total labour use are positively related to commercialization but only farm income is significant (Table 13).

In the Eastern Region, the correlation between commercialization index and farm income, land size, fertilizer use and total labour use are positively related but not significant (Table 14).

Table 11. Correlation for Brong-Ahafo region

		Value of sales ($)	Fertilizer use(US$)	Total labour use, days	Land size (ha)
Value of sales ($)	Pearson Corr	1			
	N	152			
Fertilizer use(US$)	Pearson Corr	-.035	1		
	Sig. (2-tailed)	.699			
	N	127	127		
Total labour use, days	Pearson Corr	.146	.236**	1	
	Sig. (2-tailed)	.081	.009		
	N	144	123	144	
Land size (ha)	Pearson Corr	.217**	.005	.241**	1
	Sig. (2-tailed)	.007	.951	.004	
	N	152	127	144	152

***. Correlation is significant at the 0.01 level (2-tailed).*

a. regions = Brong-Ahafo

Table 12. Correlation for Eastern region

		Value of sales ($)	Fertilizer use(US$)	Total labour use, days	Land size (ha)
Value of sales ($)	Pearson Corr	1			
	N	136			
Fertilizer use(US$)	Pearson Corr	.193	1		
	Sig. (2-tailed)	.102			
	N	73	73		
Total labour use, days	Pearson Corr	.228*	-.084	1	
	Sig. (2-tailed)	.013	.502		
	N	119	67	119	
Land size (ha)	Pearson Corr	.101	.006	.164	1
	Sig. (2-tailed)	.240	.959	.075	
	N	136	73	119	136

**. Correlation is significant at the 0.05 level (2-tailed).*
a. regions = Eastern

Fig. 2 and Fig. 3 present the commercialization status of both tomato producing and pineapple producing households, as well as the cash incomes realized by smallholder households in the study communities. The data suggest that the adoption of commercialization by households, as well as earning cash income from commercialization were higher among tomato producers. For example, among the tomato farmers average cash income increased with farm size while in the case of pineapple farmers, farmers who cultivated plots larger than 4 hectares seem not to enjoy higher incomes probably because of greater challenges in managing larger farms and uncertainty on the part of farmers with marketing their produce.

Table 13. Correlation for tomato farmers in Brong Ahafo region

		commercialization index	Farm income (US$)	Land size (ha)	Fertilizer use(US$)	Total labour use, days
commercialization index	Pearson Corr	1				
	N	152				
Farm income (US$)	Pearson Corr	.420**	1			
	Sig. (2-tailed)	.000				
	N	152	152			
Land size (ha)	Pearson Corr	-.067	.181*	1		
	Sig. (2-tailed)	.412	.025			
	N	152	152	152		
Fertilizer use(US$)	Pearson Corr	-.145	-.067	.005	1	
	Sig. (2-tailed)	.103	.452	.951		
	N	127	127	127	127	
Total labour use, days	Pearson Corr	.083	.104	.241**	.236**	1
	Sig. (2-tailed)	.324	.216	.004	.009	
	N	144	144	144	123	144

***. Correlation is significant at the 0.01 level (2-tailed).*
**. Correlation is significant at the 0.05 level (2-tailed).*
a. regions = Brong-Ahafo

Table 14. Correlation for pineapple farmers in Eastern region

		commercialization index	Farm income (US$)	Land size (ha)	Fertilizer use(US$)	Total labour use, days
commercialization index	Pearson Corr	1				
	N	136				
Farm income (US$)	Pearson Corr	.036	1			
	Sig. (2-tailed)	.679				
	N	136	136			
Land size (ha)	Pearson Corr	.135	.057	1		
	Sig. (2-tailed)	.117	.510			
	N	136	136	136		
Fertilizer use(US$)	Pearson Corr	.085	.271*	.006	1	
	Sig. (2-tailed)	.477	.020	.959		
	N	73	73	73	73	
Total labour use, days	Pearson Corr	.025	.269**	.164	-.084	1
	Sig. (2-tailed)	.789	.003	.075	.502	
	N	119	119	119	67	119

*. Correlation is significant at the 0.05 level (2-tailed).
**. Correlation is significant at the 0.01 level (2-tailed).
a. regions = Eastern

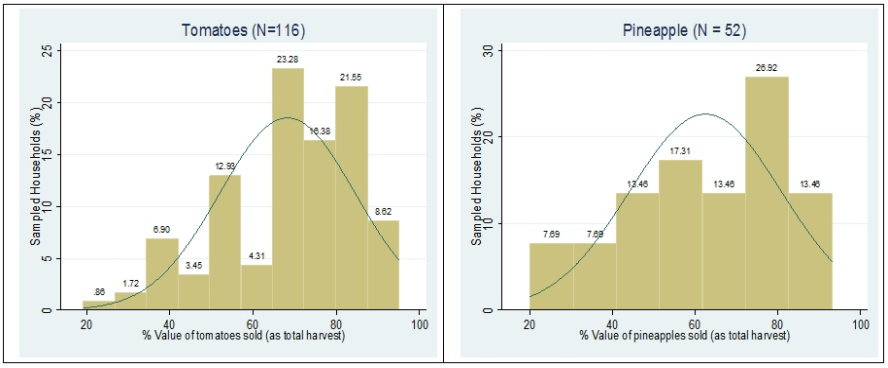

Fig. 2. Commercialization status of sample farm households

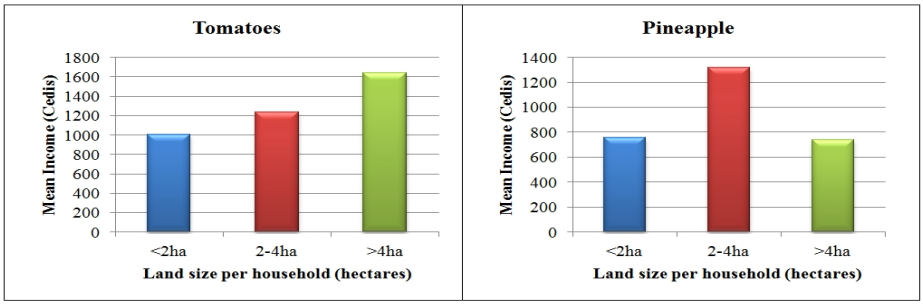

Fig. 3. Household cash income per land size (Cedis/Ha)

5.4 Determinants of Commercialization – Regression Results

In order to establish the determinants of smallholder commercialization of tomato and pineapple farming in the communities studied, a regression analysis was conducted in each case. The value of tomatoes or pineapples sold is used in this analysis as a proxy for the extent of commercialization by smallholder farmers.

The regression results for sampled tomato growers in the Brong Ahafo region with value of tomatoes sold in dollars as the dependent variable is presented in Table 15. About 68 percent of the total variations in the value of sales of tomatoes sold is explained by land productivity (value of crop in US$/ha) and labour productivity (value of crops in US$/labour days). A one percent change in land productivity and labour productivity results in a 0.70 and 0.15 percent increase in the value of tomato sales respectively.

Table 15. Regression Result for Tomato Farmers (with value of tomatoes sold)

Dependent Variable: log (Value of Tomatoes Sold) **Method: Least Squares** **Sample (adjusted): 1 115** **Included observations: 109 after adjustments**				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
Log (Land productivity)	0.701898	0.067779	10.35561	0.0000***
Log (Labour productivity)	0.145125	0.047187	3.075519	0.0027***
Log (Education)	-0.090421	0.193790	-0.466593	0.6418
Log (Fertilizer use (US$))	0.282787	0.281445	1.004769	0.3174
Log (Access to credit)	0.121443	0.213331	0.569270	0.5704
Log (Savings(US$))	-0.000240	0.030344	-0.007898	0.9937
Log (Age)	0.122964	0.795604	0.154555	0.8775
C	0.140590	1.370020	0.102619	0.9185
R-squared	0.696915	Mean dependent var		2.625353
Adjusted R-squared	0.675910	S.D. dependent var		0.542686
S.E. of regression	0.308946	Akaike info criterion		0.559259
Sum squared resid	9.640185	Schwarz criterion		0.756789
Log likelihood	-22.47959	F-statistic		33.17719
Durbin-Watson stat	1.862716	Prob(F-statistic)		0.000000

****represent significance at 1%*

The Durbin-Watson statistics (DW) value of 1.86 indicates that there is no auto-correlation (Table 15). While d can assume values between 0 and 4, values around 2 indicate no auto-correlation. As a rule of thumb values of $1.5 < d < 2.5$ show that there is no auto-correlation in the data.

The variance inflation factor (VIF) method was used in measuring the level of collinearity between regressors in the regression result for tomato growers with value of tomato sold. There are two forms of the variance inflation factor (centered and uncentered). The centered VIF is the ratio of the variance from a coefficient estimate from an equation with only that regressors and a constant. From the centered variance inflation factor, multicollinearity is low since the VIF values is less than 5.

Variance Inflation Factors			
Variable	**Coefficient Variance**	**Uncentered VIF**	**Centered VIF**
Log (Land productivity)	0.004521	36.49457	1.581015
Log (Labour productivity)	0.003031	5.920260	1.681420
Log (Education)	0.034475	38.59631	1.019487
Log (Fertilizer use (US$))	0.104721	204.0012	1.197015
Log (Access to credit)	0.042719	1.703427	1.047061
Log (Savings(US$))	0.000884	1.516366	1.111897
Log (Age)	0.434262	1379.843	1.046298
C	1.350264	1541.989	NA

Endogeneity Test

Dependent Variable: log (Value of Tomatoes Sold)
Method: Least Squares
Sample (adjusted): 1 115
Included observations: 109 after adjustments

Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
Log (Land productivity)	0.701898	0.066758	10.51407	0.0000
Log (Labour productivity)	0.145125	0.045780	3.170049	0.0020
Log (Education)	-0.090421	0.193415	-0.467498	0.6412
Log (Fertilizer use (US$))	0.282787	0.281153	1.005811	0.3169
Log (Access to credit)	0.121443	0.211215	0.574975	0.5666
Log (Savings(US$))	-0.000240	0.029916	-0.008011	0.9936
Log (Age)	0.122964	0.785856	0.156472	0.8760
Residual	0.569662	0.419156	1.359070	0.1772
C	0.140590	1.329849	0.105718	0.9160
R-squared	0.707383	Mean dependent var		2.625353
Adjusted R-squared	0.683974	S.D. dependent var		0.542686
S.E. of regression	0.305078	Akaike info criterion		0.542458
Sum squared resid	9.307229	Schwarz criterion		0.764680
Log likelihood	-20.56397	F-statistic		30.21802
Durbin-Watson stat	1.823847	Prob(F-statistic)		0.000000

**** and ** represent significance at 1% and 5% respectively*

The “augmented regression approach” was used to control for endogeneity of the determinants of smallholder tomato commercialization in the model. The “augmented regression approach” involves two stages, at the first stage; exogenous variables that explain tomato commercialization are regressed on the index of tomato commercialization. The residuals for the model are retrieved from the model. In the second stage, the residuals are used as instrument together with the determinants as exogenous variables using the value of tomato sold as the dependent variable. Since the coefficient on the residual is statistically different from zero we conclude that ordinary least square is consistent in estimation.

The probability of the observed R-squared value in the output from the white heteroskedasticity test (0.20) for tomato growers represents that it will be incorrect if the null hypothesis of no heteroskedasticity is rejected.

White Heteroskedasticity Test:			
F-statistic	1.292150	Probability	0.180046
Obs*R-squared	39.50890	Probability	0.201925

In the case of pineapple producers, Table 16 represents the regression results for sampled pineapple growers in the Eastern Region with value of pineapples sold in dollars as the dependent variable. About 70 percent of the total variations in the value of sales of pineapple growers is explained by land productivity (value of crop in US$/ha) and savings. The value of pineapples sold is expected to increase by 0.16 percent and 0.77 percent when there is a one percent change in land productivity and savings respectively. The Durbin-Watson statistics indicates that there is no autocorrelation since the value of 1.82 lies between the values of $1.5 < d < 2.5$ which shows that there is no auto-correlation in the data.

The variance inflation factor (VIF) method was used in measuring the level of collinearity between regressors in the regression result for pineapple growers. From the centered variance inflation factor, multicollinearity is low since the VIF values is less than 5.

Similar to the tomato model, endogeneity was controlled through the "augmented regression approach" for the determinants of smallholder pineapple commercialization. Two stages are involved in the "augmented regression approach". The first stage; exogenous variables that explain pineapple commercialization are regressed on the index of pineapple commercialization. The residuals for the model are retrieved from the model. In the second stage, the residuals are used as instrument together with the determinants as exogenous variables using the value of pineapple sold as the dependent variable. Since the coefficient on the residual is statistically different from zero, we conclude that ordinary least square is consistent in estimation.

Table 16. Regression result for pineapple growers (with value of pineapples sold)

Dependent Variable: log (Value of Pineapples Sold)
Method: Least Squares
Sample (adjusted): 1 50
Included observations: 42 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Log (Land productivity)	0.154739	0.061907	2.499528	0.0174**
Log (Labour productivity)	0.052692	0.038800	1.358057	0.1834
Log (Education)	0.013717	0.108604	0.126306	0.9002
Log (Fertilizer use (US$))	-0.187803	0.156564	-1.199533	0.2386
Log (Access to credit)	0.073388	0.154098	0.476240	0.6369
Log (Savings(US$))	0.765317	0.080477	9.509744	0.0000***
Log (Age)	0.687346	0.977424	0.703222	0.4867
C	-0.757166	1.596338	-0.474314	0.6383
R-squared	0.720308	Mean dependent var		2.632211
Adjusted R-squared	0.703901	S.D. dependent var		0.379277
S.E. of regression	0.117575	Akaike info criterion		-1.273831
Sum squared resid	0.470015	Schwarz criterion		-0.942846
Log likelihood	34.75044	F-statistic		56.09177
Durbin-Watson stat	1.818087	Prob(F-statistic)		0.000000

**** and ** represent significance at 1% and 5% respectively*

Variance inflation factors			
Variable	**Coefficient variance**	**Uncentered VIF**	**Centered VIF**
Log (Land productivity)	0.003833	77.91111	2.277891
Log (Labour productivity)	0.001505	3.800888	1.637486
Log (Education)	0.011795	36.76531	1.079381
Log (Fertilizer use (US$))	0.024512	120.4495	1.188020
Log (Access to credit)	0.023746	1.712275	1.263822
Log (Savings(US$))	0.006477	142.8683	2.806818
Log (Age)	0.955358	7917.279	1.136472
C	2.548294	7742.229	NA

Endogeneity test

Dependent Variable: VS
Method: Least Squares
Sample (adjusted): 1 50
Included observations: 42 after adjustments

Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
Log (Land productivity)	0.154739	0.060953	2.538668	0.0160
Log (Labour productivity)	0.052692	0.038201	1.379322	0.1771
Log (Education)	0.013717	0.106930	0.128284	0.8987
Log (Fertilizer use (US$))	-0.187803	0.154150	-1.218316	0.2317
Log (Access to credit)	0.073388	0.151722	0.483697	0.6318
Log (Savings(US$))	0.765317	0.079236	9.658656	0.0000
Log (Age)	0.687346	0.962355	0.714233	0.4801
Residual	0.180814	0.125579	1.439840	0.1593
C	-0.757166	1.571726	-0.481741	0.6332
R-squared	0.725018	Mean dependent var		2.632211
Adjusted R-squared	0.706841	S.D. dependent var		0.379277
S.E. of regression	0.115763	Akaike info criterion		-1.287140
Sum squared resid	0.442233	Schwarz criterion		-0.914782
Log likelihood	36.02993	F-statistic		50.88856
Durbin-Watson stat	1.619181	Prob(F-statistic)		0.000000

The probability of the observed R-squared value in the output from the white heteroskedasticity test (0.22) for pineapple growers represents that it will be incorrect if the null hypothesis of no heteroskedasticity is rejected.

White heteroskedasticity test			
F-statistic	1.407365	Probability	0.218434
Obs*R-squared	15.45734	Probability	0.217373

5.5 Relation between Commercialization and Food Security

5.5.1 Commercialization and the area under food crops

Using the area under food crops as a proxy for food security of the household, a correlation analysis was conducted to investigate the relationship between commercialization and food security. A low correlation value of 0.039 (Table 17) indicates that there is a positive

relationship between commercialization index (CI) and area under food crops which is not significant. This means that commercialization and area under food crops are independent.

5.5.2 Commercialization and food production per adult equivalent

The adult equivalent was measured as the number of adults in a household, using a calorie-based scale from the 10th Edition of the National Research Council's *Recommended Dietary Allowances* (Washington D.C.: National Academy Press, 1989), Ghana. Measuring household size in equivalent adults recognises, for example, that the consumption requirements of babies or young children are less than those of adults (Appendix I). The scale is based on age and gender specific calorie requirements (Ghana Statistical Service, 2007). The relationship between commercialization and food production per adult equivalent is negative, and the correlation value is -0.129 and significant (the value of 0.029 is less than 0.05 (Table 17).

5.5.3 Commercialization and food consumption scores

Based on the calorie-based scale (Appendix I), the calorie intake of sampled households range between 0.74 to 8.49 on the equivalent scale as shown in Table 18. There is a positive relationship between commercialization and food consumption score per household (Table 17) but not significant (r = 0.031, p = 0.605).

Table 17. Correlation analysis of commercialization with key variables

		Commerc-ialization	Food production/ adult equivalent	Food consumption scores	Area under food crops
Commercialization	Pearson Correlation	1			
	Sig. (2-tailed)				
	N	288			
Food production/adult equivalent	Pearson Correlation	-.129*	1		
	Sig. (2-tailed)	.029			
	N	288	288		
Food consumption Scores	Pearson Correlation	.031	-.092	1	
	Sig. (2-tailed)	.605	.118		
	N	288	288	288	
Area under food crops	Pearson Correlation	.039	-.082	.035	1
	Sig. (2-tailed)	.506	.167	.559	
	N	288	288	288	288

**. Correlation is significant at the 0.05 level (2-tailed).*

Table 18. Summary Statistics of Commercialization and Food Consumption Scores

	N	Minimum	Maximum	Mean	Std. Deviation
Food consumption scores	288	0.74	8.49	2.32	1.29
Valid N (listwise)	288				

Further analysis of the survey data shows that most farmers producing tomato or pineapple on commercial basis are self-sufficient in food and therefore food secure throughout the year (Figs. 4 and 5). For example, 77% of tomato farmers indicated they are food self-sufficient while 62% of pineapple farmers indicated the same. This suggests that commercialization has not negatively affected the food security status of smallholder farmers.

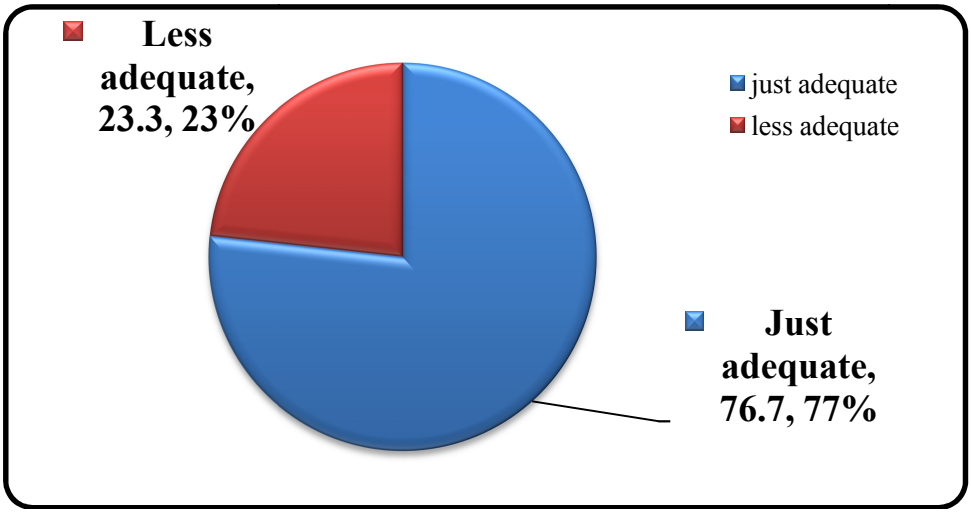

Fig. 4. Status of food self-sufficiency among tomato farmers

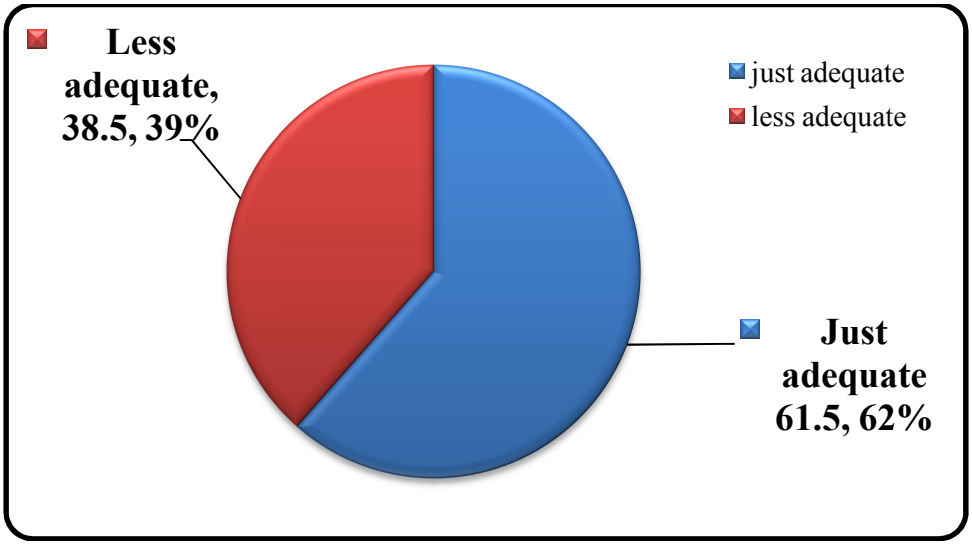

Fig. 5. Status of food self-sufficiency among pineapple farmers

6. CONCLUSIONS AND RECOMMENDATIONS

The paper focuses on the determinants of small holder commercialization of tomato and pineapple production in Ghana. It describes the characteristics of smallholder tomato and pineapple farmers in the study communities; analyses the relationship between

commercialization and smallholder land holdings; assesses the determinants of commercialization of smallholder agriculture, as well as the benefits or otherwise of smallholder farmers from commercialization; and discusses how commercialization affects household food security among smallholder farmers. A structured questionnaire was used to collect primary data from the study communities, and descriptive statistics, correlations as well as regression analysis employed to analyse the data.

As expected, 96.3% of the respondents in the study communities were farmers; and they fell between the ages of 15 and 59 years (91%), which indicates that they were relatively young. The key determinants of commercialization among tomato farmers are land productivity and labour productivity. On the other hand, the main determinants of commercialization among pineapple smallholder farmers are land productivity and savings the study also finds that in general commercialization and area under food crops as well as food consumption per adult equivalent are positively related, but negatively related to food production per adult equivalent. Moreover, most smallholders reported being food secure throughout the year with commercialization, which shows that commercialization is beneficial to them.

The study recommends that both public and private agencies should work together to facilitate the move of smallholder farmers from mainly subsistence to commercialization because it comes with several benefits, including higher household incomes, and improvements in household food security. This can be achieved partly through both public and private investments in land and labour productivity, as well as improvements in post harvest activities such as processing that will help stabilize commodity prices and thus the income of farmers. Moreover, there should be the targeting of specific commodities such as tomato and pineapple to promote into commercialization because of the high potentials such commodities provide the farmer to increase their incomes and general welfare.

ACKNOWLEDGEMENT

This study was done under the Commercialization Theme of Future Agricultures Consortium (FAC) with financial support from the Department for International Development (DFID), UK.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Timmer CP. Farmers and Markets: The Political Economy of New Paradigms, American Journal of Agricultural Economics. 1997;79:621-627.
2. Pingali P. From Subsistence to Commercial Production Systems: The Transformation of Asian Agriculture. American Journal of Agric. Economics. 1997;79:628-634.
3. von Braun J, Kennedy E, editors. Agricultural Commercialization, Economic Development, and Nutrition, the Johns Hopkins Press Ltd. Maryland; 1994.
4. Dorward A; Kydd J, Poulton C, editors. Smallholder Cash Crop Production under Market Liberalization. Oxon; New York, NY: CAB International; 1998.
5. Shepherd AW, Farolfi S. Export Crop Liberalization: A Review. FAO Agricultural Services Bulletin 000, ROME; 1999.

6. Govereh, J, Jayne TS, James N. Smallholder Commercialization, Interlinked Markets and Food Crop Productivity: Cross-Country Evidence in Eastern and Southern Africa. Department of Agricultural Economics & Department of Economics, Michigan State University (MSU); 1999.
7. Chipeta S, Hoydahl E, Krog J. Livestock Services and the Poor. A Global Initiative – Collecting, Coordinating and Disseminating Experiences. Draft Report, Danida, IFAD and The World Bank; 2003.
8. Asuming-Brempong S, Al-Hassan R, Sarpong DB, Kwadzo GT-M, Akoena SKK, Sakyi-Dawson O, Mensah-Bonsu A, Amegashie DPK, Egyir IS, Ashley S. Poverty and Social Impact Analysis (PSIA) Study of Ghana: Economic Transformation of the Agricultural Sector. Technical Report submitted to the National Development Planning Commission (NDPC)/ Ministry of Food and Agriculture (MoFA), and DFID, Accra, Ghana; 2004.
9. MOFA. Agriculture in Ghana: Facts and Figures. Annual Report compiled by the Statistics, Research and Information Directorate (SRID), Ministry of Food and Agriculture (MOFA) as part of MOFA's Policy Planning Monitoring and Evaluation. Accra, Ghana; 2009.
10. Ministry of Food and Agriculture (MoFA). "Agriculture in Ghana: Facts and Figures", PPMED, Accra; 2006.
11. World Bank. Ghana Forest Resource Management Project (Staff Appraisal Report). Western Africa Division, World Bank, Washington D.C.; 1988.
12. Chamberlin J. Defining smallholder agriculture in Ghana Published date: International Food Policy Research Institute, Washington, DC 20006-1002 USA; 2007.
13. Eaton C, Shepherd AW. Contract Farming: Partnership for Growth. Rome: Food and Agriculture Organization. Agricultural Services Bulletin. 2001;145.
14. Gabriel E, Nalukenge I, (DRAFT): Contract Farming, Smallholders and Commercialization of Agriculture in Uganda: The Case of Sorghum, Sunflower, and Rice Contract Farming Schemes. Kampala, Uganda.
15. Glover, DJ. Increasing the Benefits to Smallholders from Contract Farming: Problems for Farmers' Organizations and Policy Makers. World Development. 1987;15(4):441-448..
16. Jayne TS, Takashi Y, Michael TW, David T, Rui B, Chapoto A, Zulu B. Smallholder income and land distribution in Africa: implications for poverty reduction strategies. Food Policy. 2003;28:253–275.
17. Key N, Runsten D. Contract Farming, Smallholders, and Rural Development in Latin America: The Organization of Agroprocessing Firms and the Scale of Outgrower Production. World Development.1999;27(2):381-401.
18. Masakure O, Henson S. Why do Small-scale Producers Choose to Produce under Contract? Lessons from Nontraditional Vegetable Exports from Zimbabwe. World Development. 2005;33(10):1721-1733.
19. Porter G, Howard KP. Comparing Contracts: An Evaluation of Contract Farming Schemes in Africa. World Development. 1997;25(2):227-238.

APPENDIX

Appendix I: Recommended Energy Intakes

Category	Age (years)	Average energy allowance per day (kcal)	Equivalence Scale
Infants	0 – 0.5	650	0.22
	0.5 – 1.0	850	0.29
Children	1 – 3	1300	0.45
	4 – 6	1800	0.62
	7 – 10	2000	0.69
Males	11 -14	2500	0.86
	15 -18	3000	1.03
	19 – 25	2900	1.00
	25 – 50	2900	1.00
	51+	2300	0.79
Females	11 -14	2200	0.76
	15 -18	2200	0.76
	19 – 25	2200	0.76
	25 – 50	2200	0.76
	51+	1900	0.66

Source: Recommended Dietary Allowances, 10th edition, (Washington D.C.: National Academy Press, 1989).

Peer-review history:
The peer review history for this paper can be accessed here:
http://www.sciencedomain.org/review-history.php?iid=229&id=2&aid=1384